Food Security Dynamics in the US

Seungmin Lee
Christopher B. Barrett
John F. Hoddinott

Charles H. Dyson School of Applied Economics & Management, Cornell University

8 Feb 2021 hosted by USDA-ERS

Background

- Since 1995 US food security studies rely mainly on USDA household food security measure (HFSM), a discrete ordinal measure
- HFSM has a few limitations
  - No extended household-panel data exists.
  - Ordinal measure limits capacity to study change in FI severity
- Result: no study has >5 obs/hh, or can study transitions/ persistence beyond discrete categorical status, suppressing policy-relevant within-category variation over time
- Understanding food security dynamics can inform effective policy design/evaluation. Scant empirical literature, due to data limits.
  - How long will newly food insecure remain FI?
  - Can we identify/target chronically FI separately from transitorily FI?

A New Measure

- The Probability of Food Security (PFS) = estimated probability that hh food expenditures $\geq$ minimal cost of healthy diet, per USDA's Thrifty Food Plan (TFP) diet, reported monthly in USDA *Cost of Food Reports*.
- Adapt an econometric method (Cissé & Barrett, JDE 2018) that has been applied to study food security in the low-income world.

Advantage of PFS

- Input data more often available in HH surveys, enables longer panels
- Continuous, decomposable measure in the Foster–Greer–Thorbecke (FGT 1984 EMTRA) tradition, enabling deeper study and groupwise decomposition of FI severity.

Data

- We use Panel Study of Income Dynamics (PSID), a nationally representative hh panel survey, which included HFSM (1999-2003, 2015-2017).
- Validated as a credible data to be used for food insecurity research (Tiehen et al. 2019)
- We use balanced panel $\approx$ 23,000 obs from $\approx$ 2,700 hhs over 9 biennial waves (2001-2017) since PSID began standardizing food expenditures aggregates Table

Constructing PFS (1)

1. Estimate the conditional mean of food expenditure per capita:

$$W_{ijt} = \sum_{\gamma=1}^{3} \beta_{M_\gamma} W_{ijt-1}^{\gamma} + \delta_M X_{ijt} + \omega_{Mt} + \theta_{Mj} + u_{Mijt} \quad (1)$$

   - i, j, t: household, state, year
   - W: Annual food expenditure per capita Model
   - X: Household characteristics
   - ω, θ: Year and state FE

2. Estimate the conditional variance of food expenditure:

$$\hat{u}_{Mit}^2 = \sum_{\gamma=1}^{3} \beta_{V_\gamma} W_{ijt-1}^{\gamma} + \delta_V X_{ijt} + \omega_{Vt} + \theta_{Vj} + u_{Vijt} \quad (2)$$

where $\hat{u}_{Mit}^2$ is the squared residual series from (1).

Constructing PFS (2)

3. Construct household-period-specific food expenditure CDF$(\cdot)$ assuming $W_{ijt} \sim Gamma\,(\alpha, \beta)$ calibrating the parameters by the method of moments.
4. Define the PFS as $\hat{\rho}_{ijt} = 1 - F\left(X_{ijt}, W_{ijt-1} | \underline{W_{ijt}}\right) \in [0, 1]$ where $\underline{W_{ijt}}$ is the cost of the TFP diet (by period and hh composition).
5. HH i is food secure in t iff $\hat{\rho}_{it} \geq \underline{P_t}$, where we set $\underline{P_t}$ (assumed probability threshold) to match sample-period FI prevalence to USDA population prevalence estimate from CPS. Fig

Household Dynamics - Spells Approach

Use hh-year-specific PFS to study dynamics by 2 different methods

1st Approach

- Duration of unbroken sequence of HH FI observations.
- Hhs categorized based on FI status in consecutive waves.

$t-1$ \ t	Food Insecure (FI)	Food Secure (FS)
FI	(FI_{t-1}, FI_t) (1)	(FI_{t-1}, FS_t) (2)
FS	(FS_{t-1}, FI_t) (3)	(FS_{t-1}, FS_t) (4)

- FI considered chronic if persists $>$2 years
- Yields spell length distribution, exit rates conditional on FI status.

Household Dynamics - Permanent Approach (1)

2nd Approach

- Based on mean intertemporal PFS (chronic) and deviation from mean (transient)
- Denote total TFI_i and chronic CFI_i from the PFS sequence of hh i and its chronic component, then

$$TFI_i(\alpha, PFS_{i1}, ..., PFS_{it}) = \frac{1}{T}\sum_{t=1}^{T}\left(1 - \frac{min(PFS_{it}, \underline{P_t})}{\underline{P_t}}\right)^{\alpha} \quad (3)$$

$$CFI_i(\alpha, PFS_{i1}, ..., PFS_{it}) = \left(1 - min\left[1, \frac{\sum_{t=1}^{T} PFS_{it}}{\sum_{t=1}^{T} \underline{P_t}}\right]\right)^{\alpha} \quad (4)$$

α is aversion parameter, as in FGT, permits severity analysis

Household Dynamics - Permanent Approach (2)

- Households are classified into four categories.
  1. Persistently food insecure: $CFI_i > 0$ and $PFS_{it} < \underline{P_t}\ \forall t$
  2. Chronically but not persistently food insecure: $CFI_i > 0$ and $\exists t$ such that $PFS_{it} \geq \underline{P_t}$
  3. Transiently food insecure: $CFI_i = 0$ and $\exists t$ such that $PFS_{it} < \underline{P_t}$.
  4. Persistently food secure: $CFI_i = TFI_i = 0$
- Two methods do not overlap perfectly - households can be categorized as chronically food insecure under the one method but as transiently food insecure under the other.
- While the permanent approach is less prone to measurement error and data truncation, it assumes a stationary process.

Groupwise Aggregation

- Aggregate PFS over hhs to generate group-specific estimates.

$$FGT_t(\alpha, PFS_{1t}, ..., PFS_{Nt}) = \frac{1}{N}\sum_{i=1}^{N}\left(1 - \frac{min(PFS_{it}, \underline{P_t})}{\underline{P_t}}\right)^{\alpha} \quad (5)$$

- We generate three indices - headcount ratio (HCR), food insecurity gap (FIG) and squared food insecurity gap (SFIG) for $\alpha = 0, 1, 2$, respectively.
- Decompose into groupwise measures based on race, gender and education of hh head.

Validation of PFS

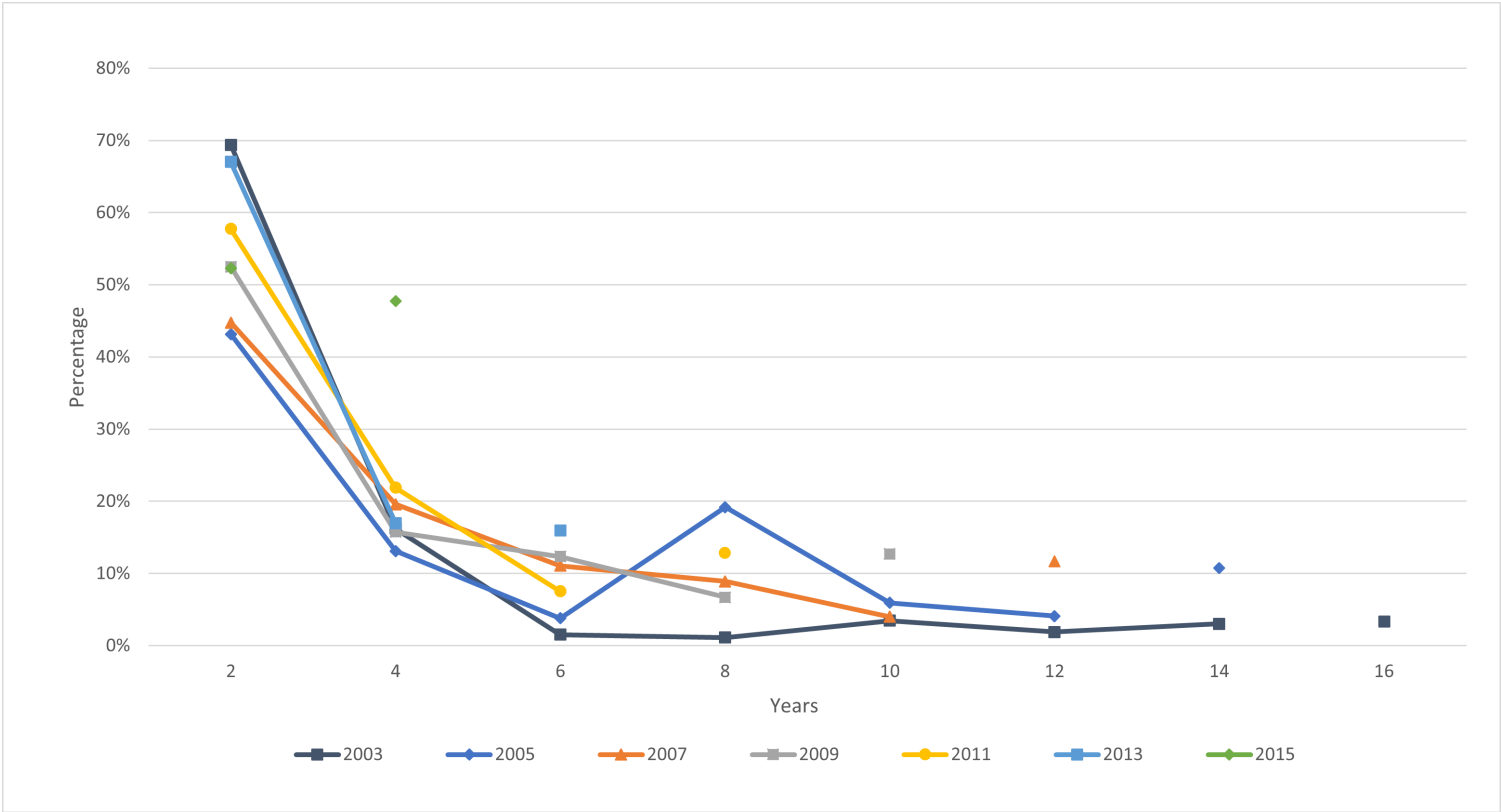
- PFS is strongly and positively correlated with the re-scaled USDA measure
  - Spearman's rank correlation/Kendall's τ are 0.31/0.25
  - Stronger association at lower range Reg Fit Dist
- There exists broad consistency of associational patterns between the two measures and household attributes. Reg
- These findings suggest that the PFS provides a useful complement to the USDA food security measure.

Distribution and Conditional Persistence

Spell Length Survey waves (Years duration)	Proportion	Conditional Persistence (Std.Error)
1 (1-4)	0.53	0.48 (0.03)
2 (3-6)	0.19	0.64 (0.03)
3 (5-8)	0.07	0.77 (0.04)
4 (7-10)	0.05	0.77 (0.05)
5 (9-12)	0.04	0.83 (0.04)
6 (11-14)	0.02	0.85 (0.04)
7 (13-16)	0.02	0.87 (0.05)
8 (15-18)	0.01	0.88 (0.03)
9 (17+)	0.06	.

- Roughly half of food insecurity spells are transitory
- The longer hhs remain food insecurity, the less likely they exit.

Spell Length Conditional on the Start Year



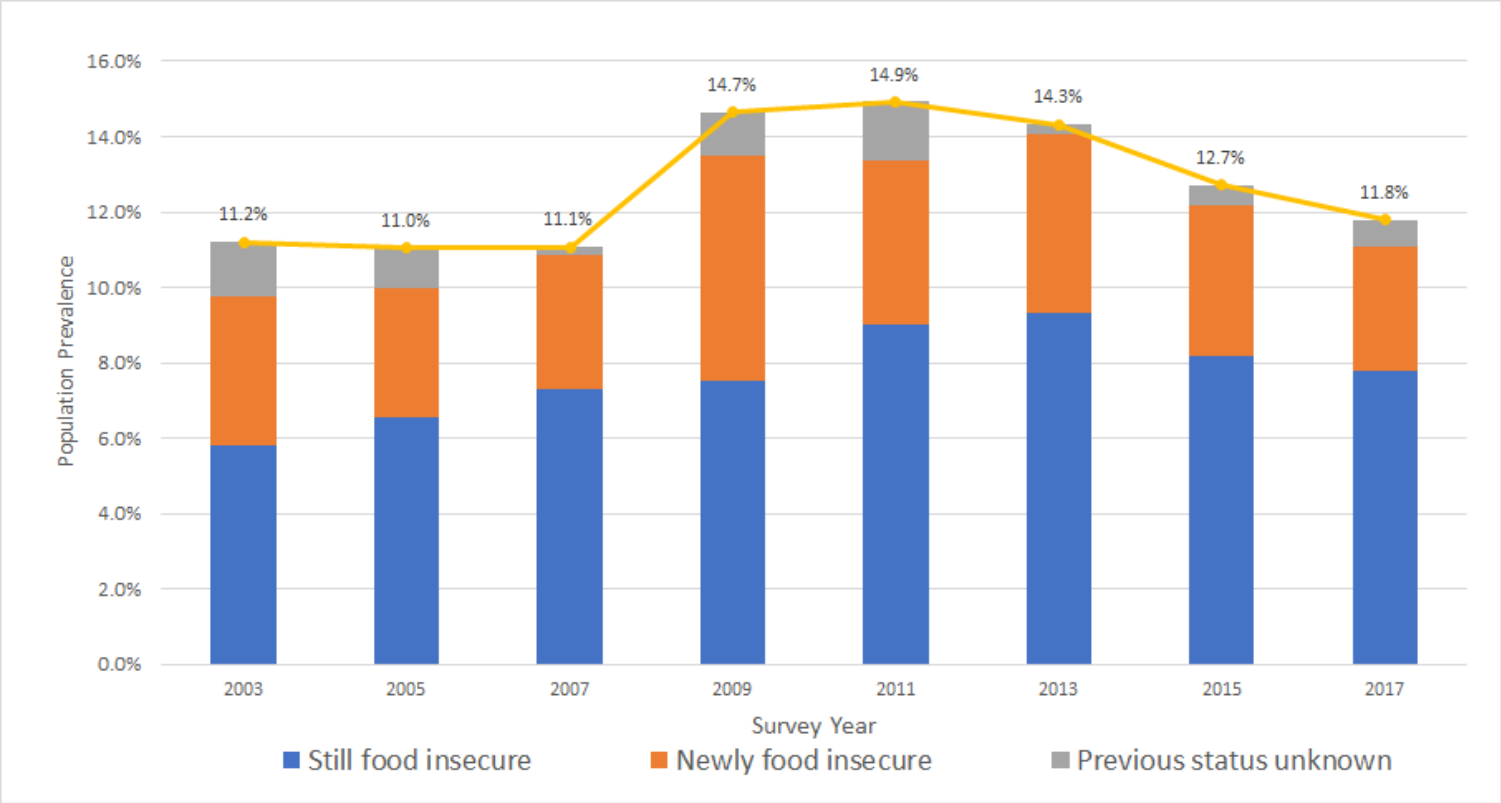
- Business cycle effect on food security

Transition in Food Security Status

	N	(FI_{t-1}, FI_t)	(FI_{t-1}, FS_t)	(FS_{t-1}, FI_t)	(FS_{t-1}, FS_t)	Persistence*	Entry*
Year							
2003	2,164	0.06	0.04	0.04	0.85	0.61	0.05
2005	2,338	0.07	0.04	0.03	0.85	0.64	0.04
2007	2,431	0.07	0.03	0.04	0.86	0.69	0.04
2009	2,411	0.08	0.03	0.06	0.83	0.75	0.07
2011	2,540	0.09	0.05	0.04	0.81	0.63	0.05
2013	2,570	0.09	0.05	0.05	0.81	0.65	0.06
2015	2,569	0.08	0.06	0.04	0.82	0.59	0.05
2017	2,590	0.08	0.05	0.03	0.84	0.61	0.04
Gender							
Male	15,215	0.04	0.04	0.03	0.89	0.54	0.04
Female	4,398	0.21	0.08	0.08	0.63	0.72	0.11
Race							
White	13,150	0.05	0.04	0.04	0.88	0.56	0.04
Non-white	6,463	0.26	0.08	0.08	0.58	0.76	0.12
Highest Degree							
Less than HS	2,561	0.26	0.08	0.08	0.57	0.75	0.13
High school	5,998	0.10	0.06	0.06	0.77	0.61	0.07
Some college	4,967	0.07	0.04	0.04	0.85	0.64	0.04
College	6,087	0.02	0.02	0.02	0.93	0.47	0.02

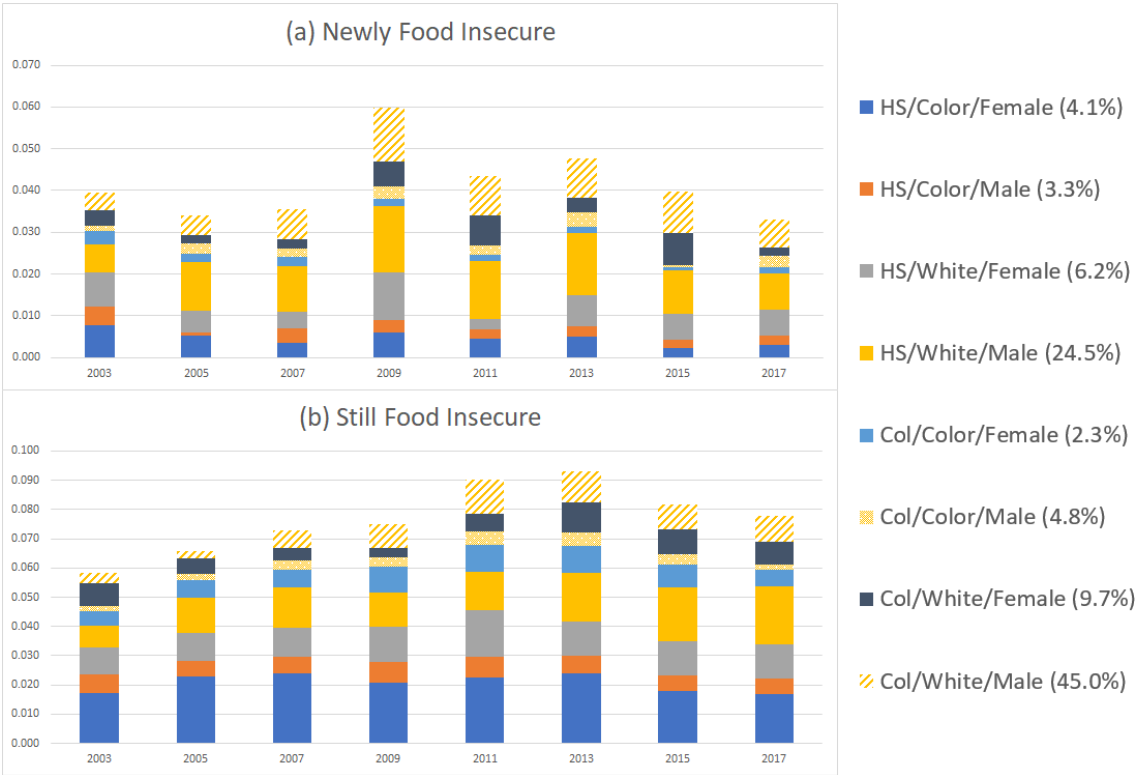
- Entry and persistence both higher during Great Recession and among hhs w/female, non-white, or poorly educated heads

Persistence and Entry by Year



- Prevalence, entry, persistence peak during Great Recession

Persistence and Entry by Demographic Group



- Share of newly food insecure hhs increased 70% during Great Recession, o/w 30% was hhs whose head is female without a college education.
- Most FI groups also most persistent, so stable entry rate around Great Recession

Chronic Food Insecurity from the Permanent Approach

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	N	TFI	CFI	TFI-CFI	(CFI/TFI)	Chronic		Transient	Never food insecure
						Persistent	Not persistent		
Total	22,324	0.124	0.092	0.032	0.744	0.026	0.066	0.210	0.698
Gender									
Male	17,291	0.076	0.044	0.032	0.577	0.010	0.034	0.191	0.765
Female	5,033	0.288	0.259	0.030	0.896	0.083	0.176	0.276	0.466
Race									
White	14,937	0.086	0.052	0.034	0.605	0.011	0.041	0.198	0.750
Non-white	7,387	0.345	0.327	0.018	0.947	0.113	0.213	0.283	0.390
Education									
Less than HS	3,307	0.355	0.318	0.036	0.898	0.114	0.205	0.338	0.344
High school	7,259	0.148	0.105	0.043	0.708	0.023	0.082	0.282	0.613
Some college	5,472	0.098	0.065	0.033	0.666	0.020	0.045	0.199	0.736
College	6,286	0.042	0.023	0.020	0.535	0.003	0.019	0.114	0.864

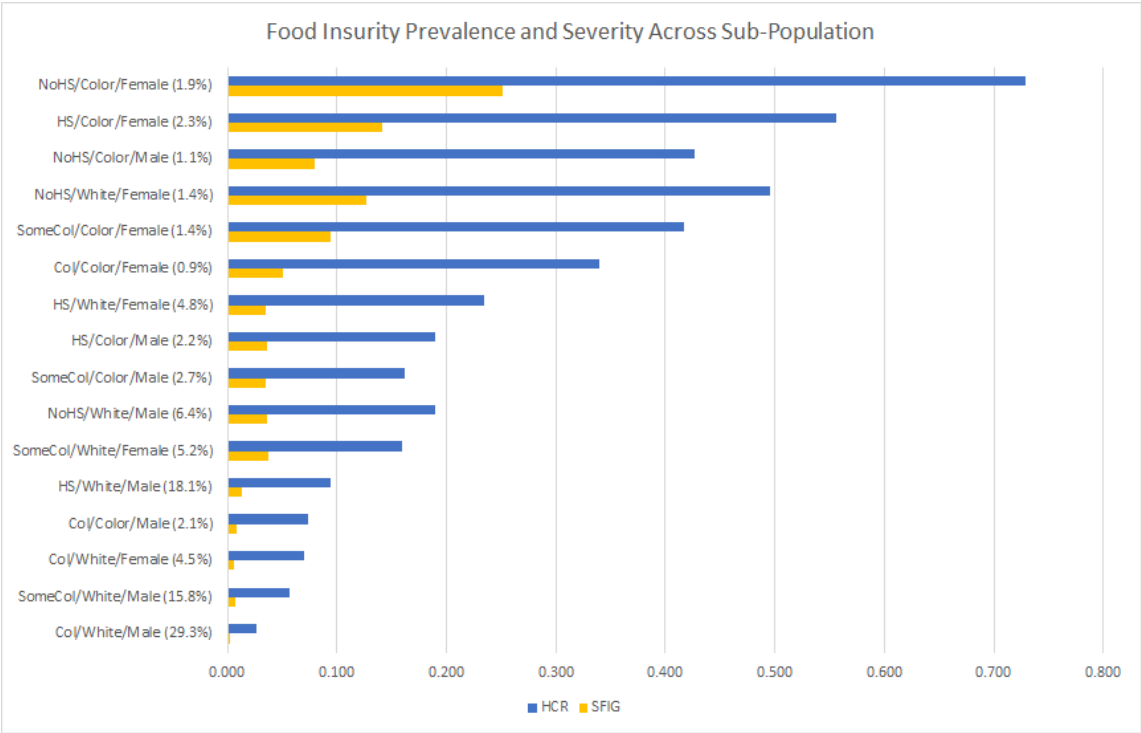
- Nearly 70% hhs never food insecure
- Among the remaining 30%, 74% of FI experience is chronic
- Most vulnerable (TFI) groups have much higher CFI (90-95%), and even more transient FI

Decomposing Variation in TFI/CFI

	TFI		CFI	
	R^2	%	R^2	%
Region	0.027	0.042	0.019	0.036
Highest degree achieved	0.052	0.079	0.037	0.072
Age	0.008	0.012	0.004	0.008
Gender	0.063	0.096	0.060	0.116
Race	0.093	0.141	0.064	0.124
Marital status	0.043	0.066	0.029	0.056
ln(income per capita)	0.152	0.232	0.112	0.217
Food Assistance (SNAP, WIC, etc.)	0.166	0.253	0.148	0.287
Others	0.051	0.078	0.043	0.084
Total	0.655	0.998	0.517	0.999

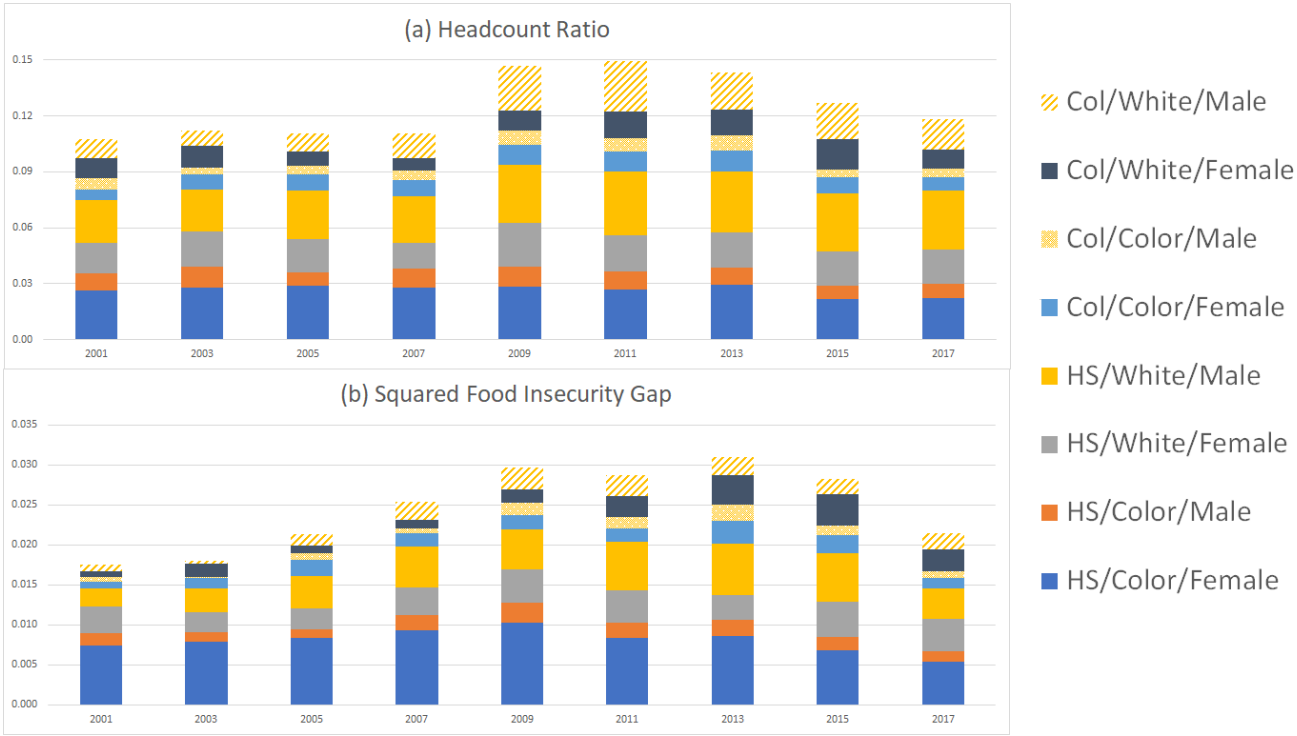
- Regional fixed effects capture merely 4% of variation. Fig
- Hh income and food assistance program participation capture $\approx$ 1/2 of variation ... budget constraints the best FI predictors.

Groupwise Food Insecurity Prevalence and Severity



- Vast groupwise gaps - HCR/SFIG of most FI groups (POC, women, no high school education) is 28/112 x that of most FS group (white, men, college grads).
- HCR and SFIG strongly, positively correlated, but higher HCR does not imply higher SFIG.

Food Insecurity by Group and Year



- HCR surge from 2007-9 mostly driven by white-headed hhs ($\approx$ 81% of the increase).
- SFIG increased steadily 2001-9, even when prevalence was relatively stable. Pre-recession surge was mainly among white, male-headed hhs, while post-recession recovery mostly occurred in women of color-headed hh w/ low education.

Summary of Findings

- Roughly half of food insecurity episodes are short-term, $\leq$2 yrs.
- FI persistence + (-) correlated with spell length (business cycle).
- 70% of households never experience food insecurity, but more than half of the food insecurity experience is chronic.
- Household budget constraints are the best food insecurity predictors with some spatial variation
- Race/Gender/Educational correlation w/income results in huge groupwise differences in FI, both in prevalence and in severity.

Questions

- How might this be usefully adapted/extended to help USDA in its food assistance and food security work?
- Are there any plans to construct geographically disaggregated Thrifty Food Plan budget cost estimates to reflect spatial price variation?

Thank you

Questions and/or comments are highly appreciated.

- Seungmin Lee (sl3235@cornell.edu)
- Chris Barrett (cbb2@cornell.edu)
- John Hoddinott (jfh246@cornell.edu)

Summary Statistics

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	Total		SRC		SEO	
	mean	sd	mean	sd	mean	sd
Household Head						
Age	56.35	13.62	56.58	12.17	53.19	23.84
Race						
White	0.85	0.35	0.91	0.24	0.01	0.20
Color	0.15	0.35	0.09	0.24	0.99	0.20
Married	0.61	0.48	0.63	0.42	0.30	0.90
Female	0.22	0.41	0.20	0.35	0.50	0.98
Highest educational degree						
Less than high school	0.11	0.31	0.10	0.26	0.24	0.84
High school	0.27	0.44	0.27	0.39	0.35	0.93
Some college	0.25	0.43	0.25	0.38	0.27	0.87
College	0.37	0.48	0.39	0.43	0.14	0.68
Employed	0.65	0.47	0.66	0.42	0.58	0.97
Disabled	0.19	0.39	0.19	0.34	0.23	0.83
Household						
Income per capita	40.26	30.43	41.60	27.30	21.71	35.24
Food expenditure per capita	3.65	2.11	3.73	1.87	2.51	3.55
Family size	2.22	1.16	2.22	1.02	2.26	2.67
% of children	0.10	0.19	0.10	0.17	0.16	0.47
Food Assistance						
Food stamp	0.05	0.22	0.04	0.18	0.22	0.81
Child meal	0.04	0.19	0.03	0.15	0.18	0.75
WIC	0.01	0.11	0.01	0.08	0.05	0.42
Elderly meal	0.01	0.07	0.00	0.06	0.02	0.24
Change in status						
No longer employed	0.08	0.27	0.08	0.23	0.10	0.58
No longer married	0.01	0.11	0.01	0.10	0.01	0.19
No longer owns house	0.03	0.16	0.03	0.14	0.03	0.33
Became disabled	0.07	0.26	0.07	0.23	0.07	0.51
N	22,556		16,602		5,954	

Model Selection

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Variables	(1) W_{ijt}	(2) W_{ijt}	(3) W_{ijt}	(4) W_{ijt}	(5) W_{ijt}
W_{ijt-1}	0.131***	0.250***	0.298***	0.323***	0.274**
	(0.00)	(0.01)	(0.03)	(0.07)	(0.12)
W^2_{ijt-1}		-0.0126***	-0.0241***	-0.0349	-0.00300
		(0.00)	(0.01)	(0.02)	(0.06)
W^3_{ijt-1}			0.000754**	0.00237	-0.00569
			(0.00)	(0.00)	(0.01)
W^4_{ijt-1}				-0.0000771	0.000782
				(0.00)	(0.00)
W^5_{ijt-1}					-0.0000323
					(0.00)
Controls	Y	Y	Y	Y	Y
Fixed Effects	Y	Y	Y	Y	Y
AIC	98.36	98.25	98.24	98.24	98.24

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Cut-off PFS

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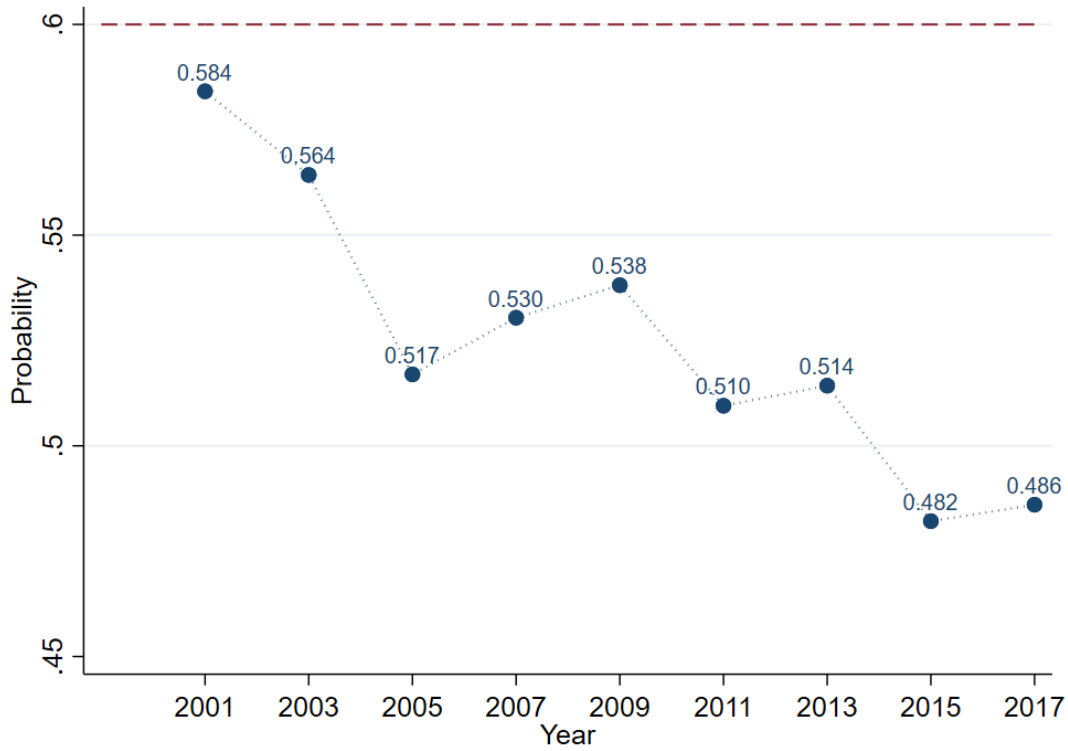

Regression of the PFS on USDA measure

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	(1) USDA	(2) USDA	(3) USDA	(4) USDA
PFS	0.179***	0.463***	0.181***	0.438***
	(0.02)	(0.08)	(0.02)	(0.08)
PFS^2		-0.216***		-0.197***
		(0.05)		(0.05)
Fixed Effects	N	N	Y	Y
N	11,793	11,793	11,793	11,793
R^2	0.116	0.127	0.137	0.145

Scatterplot and Fitted Line

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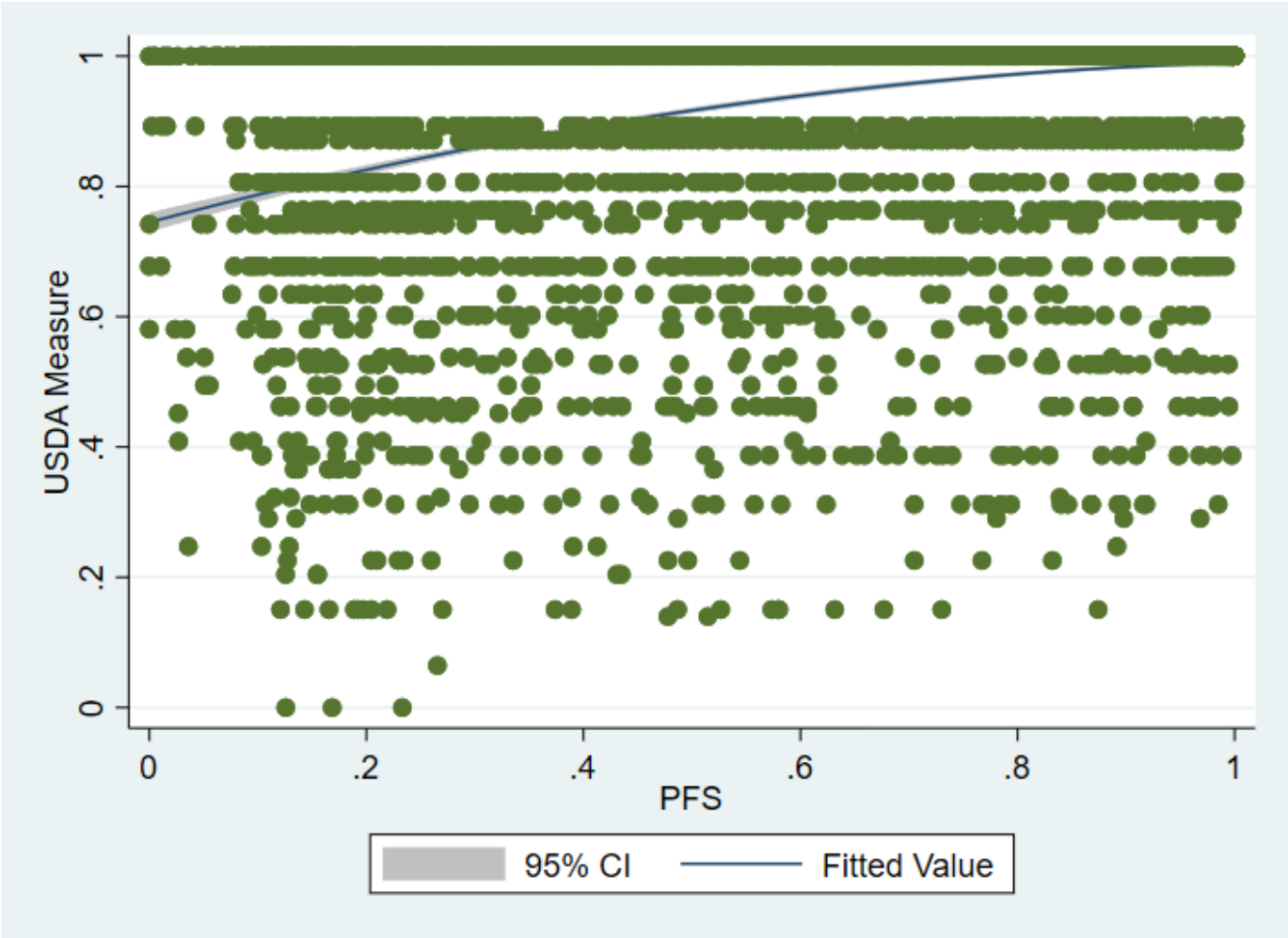

Distribution of Food Security Measures

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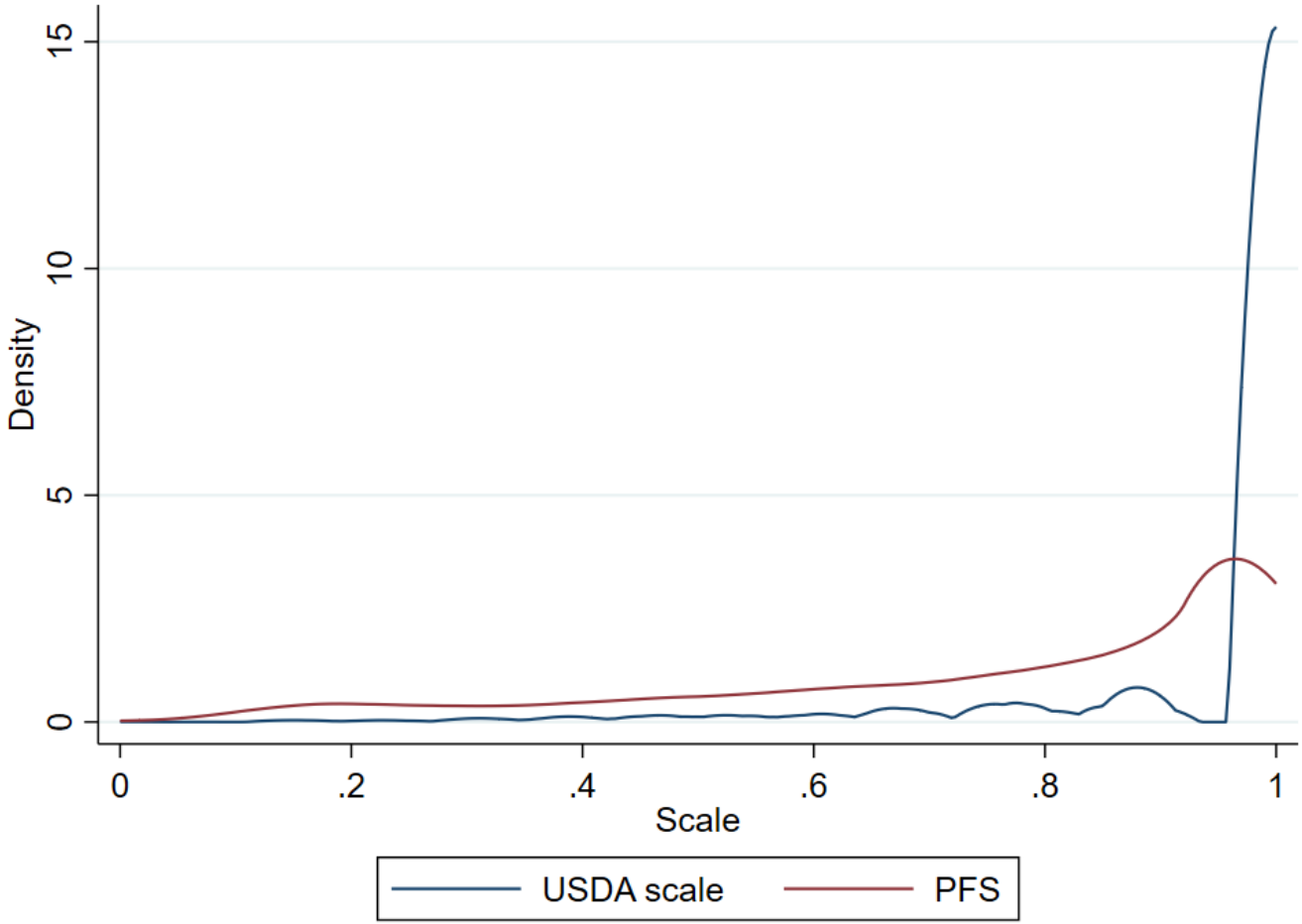

Association with Household Attributes

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	Continuous		Binary	
	(1) USDA b/se	(2) PFS b/se	(3) USDA b/se	(4) PFS b/se
Age	-0.001 (0.00)	0.009*** (0.00)	-0.002 (0.00)	0.005*** (0.00)
Age^2/1000	0.020*** (0.01)	-0.077*** (0.01)	0.035*** (0.01)	-0.041** (0.02)
Female	-0.013 (0.01)	-0.065*** (0.01)	-0.019 (0.01)	-0.067*** (0.02)
Color	-0.003 (0.01)	-0.064*** (0.01)	-0.001 (0.01)	-0.060*** (0.01)
Married	0.009 (0.01)	0.038*** (0.01)	0.020* (0.01)	0.052*** (0.01)
ln(income per capita)	0.025*** (0.01)	0.103*** (0.01)	0.038*** (0.01)	0.093*** (0.01)
Family size	0.004 (0.00)	-0.035*** (0.00)	0.004 (0.01)	-0.032*** (0.01)
% of children	0.045*** (0.01)	0.114*** (0.02)	0.070*** (0.02)	0.125*** (0.03)
Less than high school	-0.014* (0.01)	-0.018* (0.01)	-0.021 (0.02)	-0.031 (0.02)
Some college	0.002 (0.01)	0.027*** (0.01)	0.002 (0.01)	0.025** (0.01)
College	-0.001 (0.01)	0.027*** (0.01)	-0.001 (0.01)	0.009 (0.01)
Employed	0.010* (0.01)	-0.002 (0.01)	0.021** (0.01)	0.007 (0.01)
Disabled	-0.041*** (0.01)	-0.038*** (0.01)	-0.065*** (0.01)	-0.032** (0.01)
Food stamp	-0.112*** (0.02)	-0.319*** (0.01)	-0.189*** (0.03)	-0.546*** (0.03)
Child meal	-0.016 (0.02)	-0.083*** (0.01)	-0.040 (0.03)	-0.184*** (0.03)
WIC	0.004 (0.02)	-0.034* (0.02)	-0.007 (0.04)	-0.157*** (0.05)
Elderly meal	0.013 (0.03)	-0.007 (0.03)	0.035 (0.05)	-0.039 (0.06)
No longer employed	-0.005 (0.01)	-0.034*** (0.01)	0.004 (0.01)	-0.026 (0.02)
No longer married	-0.018 (0.01)	-0.033*** (0.01)	-0.038 (0.02)	0.003 (0.02)
No longer owns house	-0.002 (0.01)	0.002 (0.01)	0.007 (0.02)	0.022 (0.02)
Became disabled	0.023** (0.01)	-0.008 (0.01)	0.030 (0.02)	-0.027 (0.02)
Fixed Effects	Y	Y	Y	Y
N	9842	9842	9842	9842
R^2	0.217	0.667	0.168	0.471

Spatial Variation of TFI/CFI

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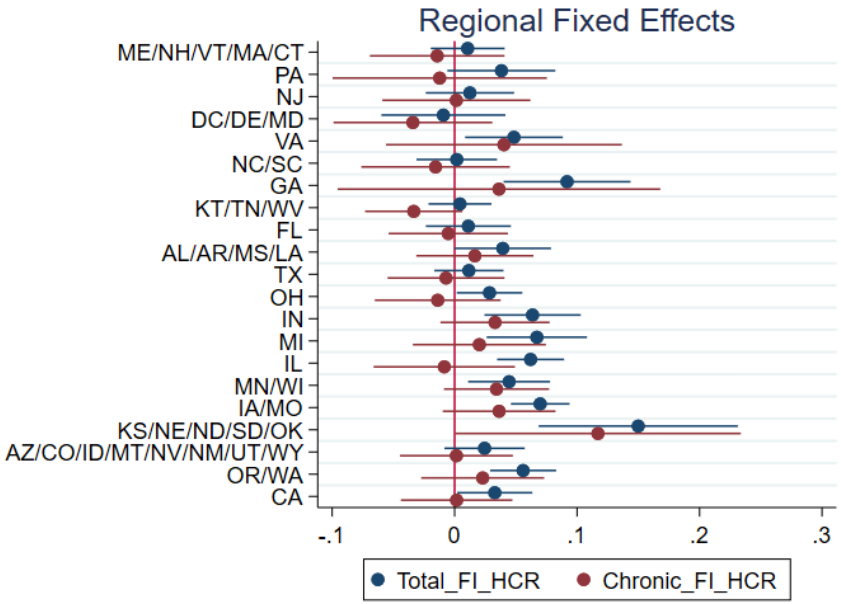

- Midwestern states exhibits significantly higher TFI/CFI